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Nuclear Deterrence in the Age of Nonproliferation

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[*] The views expressed herein are those of the author and do not represent the official position of the Lawrence Livermore National Laboratory, the Department of Energy, the U.S. Air Force, or the Department of Defense.

Biographical information

After receiving his B.S. and Ph.D. from CalTech and Stanford University, respectively, Jeff Richardson has been at Lawrence Livermore National Laboratory for 35 years. He has worked on nuclear weapons programs, the nuclear-pumped X-ray laser, and has been at different times a Division Leader for first chemistry and then later nonproliferation activities at LLNL. He recently completed a two-year assignment with the Air Force, Nuclear Operations, Plans and Requirements in the Pentagon, where he worked on RRW activities and enhanced U.S. – U.K. collaborations. A summary of the latter work, "A New Partner in Enhanced Collaboration: the U.S. Air Force," was included in the recent CSIS book, *U.S.-UK Nuclear Cooperation After 50 Years.*

Abstract

The fallacy of zero nuclear weapons, even as a virtual goal, is discussed. Because the complete abolition of nuclear weapons is not verifiable, nuclear weapons will always play a role in the calculus of assure, dissuade, deter and defeat (ADDD). However, the relative contribution of nuclear weapons to international security has diminished. To reconstitute the Cold War nuclear capability, with respect to both the nuclear weapons capability and their associated delivery systems, is fiscally daunting and not warranted due to competing budgetary pressures and their relative contribution to international security and nonproliferation. A proposed pathway to a sustainable nuclear weapons capability end-state is suggested which provides enough ADDD; a Dyad composed of fewer delivery and weapon systems, with trickle production at the National Laboratories and private sector to maintain capability and guard against technological surprise.

The Time Has Come, …

It is decision time; the United States is very close to the tipping point with respect to the future of its nuclear weapons capabilities. If nothing is decided, the U.S. nuclear capabilities will continue to atrophy and soon reach a state of complete incapability.

There is serious debate underway on the decision to reshape or reduce the U.S. nuclear weapons capability with an awareness of the chain of events that any decision will bring into play. Decisions made in the near future will have national and international security implications for the next fifty years. These decisions will effect organizations and treaties (e.g., NATO, IAEA, START, NPT, CTBT), current and future nuclear weapon states, and influence future diplomacy and security options. There is indecision as to how to best proceed to promote nonproliferation, international security and an overall reduction in the global nuclear arsenal. There appear to be two major positions dominating the discussion:

First, there is increasing momentum to advocate large reductions in the U.S. nuclear arsenal, with the ultimate goal of zero nuclear weapons. [1, 2, 3] Advocates for this direction cite several reasons, including the demise of the Cold War, [4] obligations under the Nonproliferation Treaty,[5] and a general moral imperative for the United States to seize the high ground and unilaterally lead the world towards a safer, less threatening future.[6] A decision in this direction is still tempered by the realization that until the zero level is reached, the safety and security of the remaining nuclear arsenal requires the continued development and application of supporting technology and continued sound management and best practices.

Second, advocates for some level of continued reliance on nuclear weapons for U.S. and international security.[7, 8] This position is also faced with aging and reliability issues with respect to both the nuclear warheads and the delivery systems,[9, 10, 11, 12] as well as a degrading

infrastructure with respect to the people,[13] nuclear weapons complex,[14, 15] and military industrial complex.[16] Unlike the zero proponents, this side has to decide very soon which warheads to replace, how many, and how to maintain / upgrade / replace the delivery systems and associated nuclear complex and civilian industrial bases. There is no giant money bin to fund a one-for-one replacement; careful trade-offs in type and number have to be made in an economically competitive environment. The last round of nuclear systems has lasted on the order of 50 years; the decisions made now will carry the U.S. for the next 50 years.

Decisions cannot be made without both an overarching national strategy and specific, corresponding and supporting requirements.[17, 18, 19] This paper will outline one strategy with first-order requirements. It will argue that a verifiable global abolishment of nuclear weapons is not possible. Therefore, the U.S. diminishes both its national security and overall global peace efforts by either unilaterally going to zero weapons or holding that as an ultimately obtainable goal. However, the rationale for the U.S. maintaining nuclear capability does not support the current limits under SORT (Moscow Treaty). The nation simply cannot afford to replace even a substantial fraction of the Cold War nuclear complex. A much more cost-effective program is suggested, which provides latitude for the U.S. to address additional threats to national and international security which are less amenable to nuclear deterrence. This approach is consistent with the four requirements for the future U.S. nuclear weapons posture:

1) Consistent with an articulated, overarching, Congressional-requested strategy
2) "Right-sized" NNSA weapons complex and DoD sustainable delivery systems
3) Cognizant of infrastructure, technology and budgetary constraints
4) Compatible with the role of international partnerships and U.S. global diplomatic efforts

Whither Nuclear Deterrence?

There are numerous books, articles, testimony, speeches and interviews regarding whither nuclear deterrence. [1, 3, 4, 6, 20, 21] Much of the discussion is clouded with fuzzy and/or wishful thinking:

1) a world without nuclear weapons is an achievable goal;
2) zero nuclear weapons should be the U.S. national goal;
3) the U.S., by unilaterally achieving a state of zero nuclear weapons, or even striving towards a goal of zero nuclear weapons, will encourage other nations to renounce or not develop nuclear weapons;
4) with the end of the Cold War, nuclear weapons are obsolete;
5) all the advantages of deterrence, if they ever existed in the first place, are not applicable in today's environment of asymmetric threats and one (perhaps declining) superpower.

None of these assertions are credible.

1) Verifying the total global absence of nuclear weapons is inconceivable.[22, 23] While increased safeguards, inspections, and all the worthy efforts of treaties, the IAEA, and organizations such as the Nuclear Suppliers Group, it is technically impossible to guarantee that no reasonable state, rogue state or sub-national organization is totally bereft of any nuclear weapons. In the absence of nuclear deterrence, the group with one weapon is king;[24] it would be the real life actualization of a James Bond thriller.
2) Nuclear weapons continue to have value to assure, dissuade, and deter, provided that the capability and credibility to defeat remains. Many nations (e.g., Japan) continue to forgo the development of nuclear weapons because of the U.S. umbrella. The U.S.

would be at a huge strategic and military disadvantage if it alone renounced nuclear weapons.

3) Disarmament and nonproliferation are frequently confused in discussions concerning the future of nuclear weapons. Nations may choose to develop nuclear weapons independent of the U.S. stockpile; a frequent rationale is the U.S. conventional military superiority drives nations to develop nuclear weapons to deter the U.S. Allies, assured by a credible U.S. nuclear umbrella, forgo the development of nuclear weapons. Thus, certain aspects of nuclear proliferation will occur independent of the U.S. nuclear stockpile. In other cases, nuclear disarmament by the U.S. may promote nuclear proliferation, once the U.S. nuclear umbrella ceases to be credible or existent.
4) Russia continues to have a substantial nuclear arsenal, and Russia is modernizing BOTH the nuclear arsenal and associated delivery systems.[25, 26] While not at the height of Cold War adversity, Russia continues to be a regional power with aggressive tendencies. The size of the nuclear stockpile necessary to provide deterrence to the potential nuclear threats of Russia and China is less, but the existential role of such a nuclear deterrence is not.
5) Deterrence can take different paths to the same desired end state of maintaining peace. While not always successful, deterrence always is derived from withheld military capability: the Great White Fleet, the Maginot Line, nuclear deterrence during the Cold War, limitations[27] of Columbian drug wars. The enhanced complexity of threats to international stability is exactly the reason why one-for-one replacement of weapon and delivery systems is not appropriate; it is not economically viable, given all the other demands on the U.S. military structure. However, even in

the presence of new state actors in the international security arena, a niche role for nuclear deterrence is still required. It continues to function as it did during the Cold War (with all those pluses and minuses, and shades of interpretation), plus has some additional value against more diverse WMD threats from new state actors (e.g., deterrence of Iraqi use of CW weapons in the First Gulf War).

There is one simple reason to continue to maintain some level of nuclear capability: the world is an uncertain, confusing place. Not only do things change fairly quickly (e.g., the China ASAT "demonstration," the rebirth of Russian militarism, the Georgian conflict, the confusion and turmoil in Ukraine and Turkey), but things also happen which are difficult to precisely predict (e.g., the Bhutto assassination, North Korea vacillations, Syrian objectives). Table 1 simplistically restates the old saw regarding not knowing what you don't know in an international diplomacy context. Deterrence is most useful when applied to entities which you understand and have interacted with extensively, over many topics and time; then there is some basis for prediction. When there is much less in common, the future is even harder to predict, and traditional deterrence is of less value, although not negligible. For example, Middle Eastern states do strange things sometimes.

	Agree	Don't agree
Understand	Europe, India, Brazil, Argentina	Russia, China, Venezuela
Don't understand	Middle East	Middle East, N. Korea, Iran, Pakistan, terrorists

Table 1. The foreign policy conundrum

It is clear that different cultures have difficulty in communicating and seeking common understanding, consistently.[28, 29] Consequently, other nations seek nuclear weapons both for risk mitigation and hedge; mitigation to decrease the probability of an occurrence (e.g., U.S. preemptive sanctions or invasion), and hedge to decrease the probability of consequence (e.g., regime change). Neither of these motivations depend on U.S. nuclear weapons, hence they are independent of the existence or size of the U.S. nuclear arsenal. Similarly, the U.S., in dealing with these challenging diplomatic challenges, may use its nuclear capability to limit proliferation and mitigate / hedge against potential undesirable foreign excursions. For example, when Iran acquires a nuclear capability, would the world be safer, in the absence of a (further) extended U.S. nuclear umbrella, for a domino effect of nuclear capability[30] being acquired by Saudi Arabia, Egypt, Turkey and then perhaps Greece? Finally, the U.S. may, for other reasons, have competing motivations (e.g., the recent nuclear agreement with India is a triumph of economic aggression over arms control restraint). Nearly 50 nations "now know how to make nuclear arms;"[31] a variety of diplomatic and military tools are needed to limit proliferation. A modest but credible nuclear capability provides one flexible tool to accommodate new developing strategic relationships, sometimes with nations which are less predictable, while assuring traditional allies of the merits of nonproliferation.

There are a variety of other international issues that influence the future of the U.S. nuclear capability and its effect on promoting nonproliferation and international security:

1) Homeland Security, or the impossible dream. All of the worthy efforts after 9/11 to protect the U.S. (or any country) from terrorist attack serve to mitigate the risk (i.e., decrease the probability). The smuggling into the U.S. of WMD, in its entirety or as components, is undoubtedly more difficult, but no detection system

is 100%. Thus, there are no guarantees, and a vanishing probability times an infinite consequence is always a difficult equation to analyze. Homeland Security should be thought of as an onionskin of defense; the outer layer should be "over there." The U.S. nuclear umbrella, which assures allies and dissuades some nations, with both results being a diminution of proliferation, contributes to Homeland Security as part of the outer layer of the onionskin. A robust Homeland Security program should not be taken as conclusive support for a policy of zero nuclear weapons; it is synergistic with a finite stockpile.

2) Attribution and nuclear forensics. The ability to trace a terrorist weapon to its component source undoubtedly also contributes to deterrence, but also represents an immense technical challenge. In addition to the technical challenge of relating debris to point of origin, providing evidence regarding chain of custody responsibility will be at least equally demanding. Given that the world will always be confronted with the existence theorem of nuclear weapons, attribution coupled with U.S. nuclear capability provides some level of dissuasion and deterrence.

3) The inevitable growth of nuclear energy, accelerated by climate change concerns, regardless of the level of safeguards and how the fuel cycle is closed, means that the most difficult component of nuclear weapons will always exist and be subject to diversion, purification and enrichment.[32] Because the world has never been composed solely of honorable gentlemen, the prudent course of action would be continued to have a nuclear capability with its associated deterrent benefits.

4) The definition of the world is changing.[33] While not seriously challenged militarily in the conventional sense, the U.S. is only one of many players in the

international economic market. Hopefully there will be a renaissance in international diplomacy, but, for the foreseeable future, new agreements will be more simply worded, more likely to be bilateral, and be divested of complicated verification schemes. Consequently, the U.S. will require more flexibility in how it attempts to influence and respond to international events. Unilaterally divesting itself of a nuclear capability would not be prudent. But serious reductions can and should be made, both with respect to warhead and delivery system diversity.

The Past Is Not Prologue

There are numerous opinions regarding the future of the U.S. nuclear stockpile. Almost all of these opinions take a 90,000-foot view. One view, which the preceding section has argued against, is to reduce the stockpile to zero. That should never happen. Zero is not even a viable asymptotic goal, and is misleading at the next level of detail, when specific systems and numbers have to be discussed and decided upon. The other view predominantly supports some reduced-in-scale manifestation of the current Triad. The current Triad is notionally depicted in Table 2.

Just as zero is not a viable future, it is equally flawed to consider that the U.S. should maintain a nuclear capability similar to the current Triad in the future. The logic behind that will be described in some detail, but briefly there are two reasons: 1) it is unnecessary to achieve the level of assurance, dissuasion and deterrence foreseeable in the 21st century, because of, not in spite of, the multiplicity and complexity of future nation state and asymmetric threats; 2) it is

	B61	B83	W80	W76	W88	W78	W87
B-2	X	X					
B-52	X	X	X				
F-15/16	X						
F-35	X						
MMIII						X	X
D5				X	X		

Table 2. The current U.S. nuclear capability, both warheads and associated delivery systems.

simply too expensive, given the investment in delivery systems which is necessary to enable potential nuclear warheads of the future.

The current U.S. nuclear capability is beset with technical, organizational, operational, and infrastructure challenges. The following is representative but by no means all-inclusive:

Technical

1) Material unavailability. Simply replicating the nuclear weapon system builds of the 1960's - 1980's cannot extend the U.S. nuclear capability forward in time. Many of the materials are no longer available; in some cases, because of more stringent environmental standards, and in other cases because the market for those materials has vanished and hence both the materials and associated manufacturing processes discontinued. The classic example is the carbon-carbon composites used for current reentry vehicles / bodies. The original rayon fiber, which was the carbon fiber precursor, is no longer available. Evaluation of both domestic and various foreign material has failed to reveal a suitable substitute. A company that has since gone

bankrupt supplied the original coal tar pitch used as the matrix material. Effort was made to stockpile this material, but, because it is a natural product, the shelf life is expected to be very short. Thus, in both cases new materials have to be identified, possibly synthesized and qualified, and then procured. Both the Air Force and Navy have surplus reentry vehicles / bodies (Mk 12A, Mk21, Mk5), but would have great difficulty in acquiring more. Hence, one of the tenets of the enhanced U.S. – U.K. collaboration is that, if new reentry vehicles are needed, the U.K. is on its own.

2) Surety. Any reconstitution of the U.S. stockpile will emphasize enhanced surety. The DOE and DoD have slightly different definitions of surety. Both include safety and physical security in the definition, but the former includes use control and the latter includes accuracy. All of these characteristics are critical in a safe, modern nuclear stockpile. The enhancement of surety is complementary to the reduction in yield and amount of SNM (Special Nuclear Material, here referring to enriched uranium or weapons-grade plutonium), both of which were attributes of the proposed RRW initiative.[34, 35] RRW, compared to legacy nuclear weapons, would have smaller yields and be more reliable (i.e., enhanced margins and reduced uncertainties). Hence, the total stockpile would be reduced. Large augmentation and reserve stockpiles would not be necessary, as the U.S. would have higher confidence in the deployed stockpile. Thus, the total inventory of weapons and SNM would decrease, consistent with NPT goals. If deterrence fails and the nuclear weapons are actually used, collateral effects would be minimized. The corollary to RRW is that lower yield weapons have to be more accurate (i.e., reduced CEP) to achieve the same probability of destruction, especially in a counterforce scenario. Achieving that enhanced accuracy is not a

minor undertaking. Scenarios that require enhanced accuracy are splendid catalysts for spirited debate.

Organizational

1) OSD focus. Nuclear has disappeared from the OSD organization chart. It is buried in a policy organization entitled Special Operations / Low Intensity Conflict, an ironic assignment, under a DAS who has additional non-nuclear responsibilities. It remains to be seen how the new Obama Administration and the upcoming NPR (Nuclear Posture Review) will adjust the relative importance of nuclear and WMD in the DoD policy and ATL (Acquisition, Technology and Logistics) hierarchy, but the Schlesinger Task Force has made forceful recommendations.[36]
2) Air Force. Following a series of mishaps in its year of discontent, inconceivable two decades ago, the Air Force is recommitting to its nuclear mission and making appropriate organizational changes. The results of a Blue Ribbon Review, a Defense Science Board review, and the Schlesinger Panel (requested by the SecDef) have or are in the process of making recommendations to significantly alter the organizational responsibility for nuclear operations in the Air Force.[36, 37] While many previous panels have made similar recommendations over the last 2 decades,[38] the Minot incident in particular has highlighted for the Air Force and the nation just how much complacency has set it with respect to handling of nuclear weapons. However, there still are internal service hurdles to overcome, and the recalibration of authority, responsibility, and associated funding priorities needs to be institutionalized. Major decisions have yet to be made with respect to adequately funding the newly defined nuclear mission for the next fifty years.

Operational

1) Reliability and performance are cornerstones to a credible nuclear deterrent. As the number of weapons and weapon systems declines, it is even more important to have the utmost confidence in the systems in place. There are a number of issues regarding current stockpiled nuclear weapons and their associated delivery systems. Many of these issues are fundamentally rooted in the lack of attention and funding devoted to the nuclear mission by the services, given the current additional security threats in the present world. The result is the pitfall of making locally optimized decisions without consideration for the overall system effect. A good example is RRW, designed to modernize the stockpile, improve reliability, minimize fissile nuclear material and enhance surety. The RRW program, if executed, would achieve all of those desirable attributes. For RRW to be of military utility comparable to the current legacy weapons over a range of countervalue and counterforce scenarios, however, there has to be a corresponding increase in accuracy to compensate for the decreased yields. That additional requirement has not been effectively factored into the cost equation. It's actually worse than that, because the most obvious technology to implement improved accuracy is GPS. In many potential scenarios, that would result in an assured increase in accuracy. However, it is easy to envision, even in limited potentially nuclear escalation scenarios, a GPS-denied environment (hence one of the significances of the recent China ASAT demonstration). There are not well defined, technology advanced alternatives of mature technology readiness levels. A second example is the possibility of missile defense, and the corresponding requirement for maneuverable reentry vehicles (MaRV) in order to maintain a missile-based deterrent.

The only part of a MaRV system that has been discussed is the warhead, not the logical way to approach the problem. Both of these technical challenges will require considerable technical work and, in the case of MaRV, additional policy agreement (Falcon currently is restricted to conventional payloads).[39]

Infrastructure

1) NNSA complex. The Department of Energy is in the midst of planning a transformation of the nuclear weapons complex.[15] After an initial transition period that defined Stockpile Stewardship as a stopgap measure,[40] DOE is planning a long-term effort to convert its Cold War legacy infrastructure to a smaller, safer, more secure and less expensive nuclear weapons capability. Successive iterations have been downsized to the current transform-in-place paradigm, driven primarily by avoidance of projected transformation costs. The SPEIS summarizes current thinking and a number of examined alternatives (e.g.,, Consolidated Plutonium Center). Unfortunately, it is impossible to size a future capability without a strategy or requirements list that the facility must support or satisfy. It is argued that the capability (conceptually similar to what supported the Cold War, hence remarkably status quo) needs to be maintained to provide future flexibility, even if it is never used.[11] That position is an expensive luxury, in a time of government rescue of capitalism, health care malaise, aging populace, and immigration uncertainty. Only Russia has such a redundant nuclear weapons complex comparable to that of the U.S. Other nations, such as the UK and China, support their nuclear deterrents with a much smaller, leveraged capability. Fundamental, “eternal” questions regarding outsourcing of nonnuclear components and the nature of the two-lab system cannot

be addressed without an existential strategy. Even peer review can be simplified in a world of no testing, QMU (a certification methodology based on Quantification of Margin and Uncertainties), and limited demands on the nuclear deterrent. After all, the Little Boy design was never tested, in a world of no computers, electronic calculators, or independent peer review. Israel has maintained a suspected robust nuclear deterrent with no proven and attributable tests.[24] As the previous U.S. complex had an effective lifetime of approximately 50 years, now is the time to appropriately size the U.S. nuclear complex for the next 50 years, based on a rational expectation of need versus a desire to maintain existing capability as a hedge against future uncertainty.

2) Air delivered. There are significant operational advantages to maintaining a portion of the U.S. nuclear capacity as an air-delivered option. Only air delivery, whether ultimately direct attack or standoff, provides a recall option. Air delivery requires a high likelihood of penetration, so would have limited attack scenarios, but nothing focuses the attention like a nuclear weapon-loaded aircraft just outside a country's airspace.

The difficulty is that the development time and expense for a new bomber is lengthy and large. It takes decades now to develop a new manned military aircraft. The JAST/JSF/F-35 development cycle began in the mid-1990's, building on a variety of smaller advanced manned flight programs.[41] At an initial price tag of about $100M per plane, the first production unit has not yet been delivered to the services. Full production is expected by 2013, with the DCA (dual capable aircraft) which would be nuclear capable not expected until beyond 2015 (Block 4). The Air Force

waxes and wanes about the next manned bomber (e.g., Next Generation Bomber (NGB), Next Generation Long Range Strike (NGLRS)), with the latest manifestation projected to be fielded in 2018. By analogy with the F-35, that is highly unlikely. Even worse, there is no discussion of a cruise missile follow-on to the ALCM, which, like the B-52 and MMIII, is being pushed continually out to longer service times (ironically, the newer Advanced Cruise Missile has already been retired). And there remain a number of vexing "details" which have to be resolved (e.g., transitioning from an analog based nuclear warhead inventory to a digitally based air platform).

3) Ballistic missile industrial infrastructure. The U.S. military ballistic missile infrastructure is approaching a large valley of stress, if not death. The Air Force continually refurbishes the MMIII, now with an expected service life of through 2030. Peacekeeper has been dismantled; plans for a future MMIII, the Land Based Strategic Deterrent, have been indefinitely postponed. The Navy is concluding trickle production of the D5, and will maintain the D5 well past 2030.[42, 43] There has been repeated consolidation in solid propellant manufactures, to a point where only ATK survives. At least the Navy is beginning plans for the D5 successor (i.e., aptly named the Sea Based Strategic Deterrent, not without conscious irony), but that is not expected to be in-service until past approximately 2040. The conundrum facing the U.S. is how to maintain, and at what funding, technology and capability level, the manufacturing infrastructure and expertise associated with ballistic missiles until the next missile crisis is reached more than 20 years from now.

Figure 1 notionally depicts the large future investment that will be required to replace and sustain the nuclear deterrent. The single-purpose delivery systems drive the cost, and the investment to recreate the infrastructure of the mid-20th century is overwhelming.

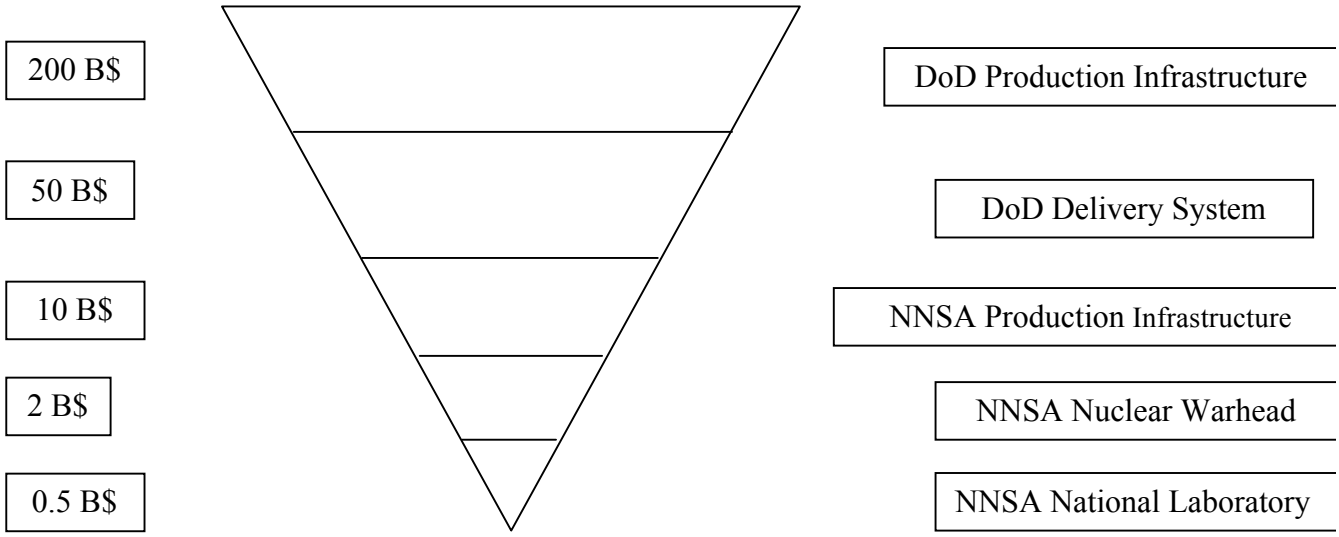

Figure 1. The infrastructure inverted pyramid (actual $ numbers are notional, but approximately correct; a more exact accounting would first require consensus on definitions).

One Potential End State

In making future plans, the making process is frequently more valuable than the product plan. The current debate revolves around a mix of conflicting policy objectives, diverse technology pathways, all herded by the inadequacy of funds. Congress is requesting a comprehensive strategy,[17] instead of making tactical decisions in a piecemeal fashion.[44] Rather than continue to sit at 90,000 feet and debate the merits of all or nothing, better to suggest alternate footprints on the ground and debate which set of tracks lead to achievable (both technology achievable and fungible), risk mitigating (not eliminating) end states.

The U.S. has embarked on a life-extension program of the W76, which, it is claimed, will extend the useable lifetime on the order of 20-30 years; the first production unit has been

delivered by NNSA. The W76 on the D5 provides the bulk of the SLBM deterrent. It also coincides with expected lifetimes of the Ohio-class submarines and the D5 (albeit with its own corresponding life extension program). The W76 LEP does not require a new plutonium pit production facility. In fact, the expected lifetime of the W76 LEP belies the specific need for RRW-1, one of the many hiccups in that star-crossed gambit. The Navy, although not error free, has a substantial, dedicated, largely effective infrastructure to manage the operation of its SLBM fleet (service facilities, dedicated career paths, test program). The SLBM fleet is not easily titratable; the baseline infrastructure to maintain loaded Ohio-class submarines at sea is considerable. Barring unforeseen technical surprise, the SLBM was always the most robust of the Triad legs. Let it remain so. Additional options, as natural lifetimes are reached, are arguably unnecessary (e.g., the W88 could be allowed to fail gracefully, much like TLAM-N). The SLBM fleet is largely a countervalue deterrent, broader and more capable but similar in scope to the UK deterrent. The reasons to maintain both are similar.

There are a variety of conceivable policy reasons to maintain an air-delivered nuclear capability. They can be forward based (e.g., NATO support), hence visible manifestation of the extended nuclear umbrella. They are subject to recall. They focus attention. The delivery platforms can be dual use capable, hence avoiding the necessity of a dedicated nuclear-only service infrastructure. And they have limited application with a longer time constant, relying on pre-established air superiority for successful penetration. The stockpile numbers are modest; this is not a Russia or China deterrent. Consequently, various proposed reuse options to extend the lifetime of current stockpile bombs are viable, without extensive infrastructure modernization. Once again, a “surety-enhanced”, life extended option for the B61 family would maintain this

nuclear capability for several decades, suitable for use against a multitude of potential emerging or asymmetric threats.

There are fewer compelling reasons to argue for the maintenance of the third Triad leg. Many of the issues revolve around funding and aging infrastructure. The basic infrastructure dates back to the 1960's, although it has been continuously upgraded, particularly recently with respect to physical security. The MMIII is on its last major life extension with dwindling test resources and no visible support or infrastructure to begin the necessary planning for a complete replacement. Some of the warheads face large refurbishments themselves, with limited facilities and competition with the W76. Improved surety, more important for the land-based ICBM force, requires upgraded accuracy. The salient national security benefit is overwhelming prompt response plus a compelling necessity to attach CONUS, a tangible but dwindling risk mitigation argument for sustainment.

Table 4 is one possible end state for the first half of the 21st century.

	B61[δ]	W76[δ]
B-2[*]	X	
F-35 [#]	X	
D5		X

Table 4. One possible future deployed U.S. nuclear capability (could envision ramp-down vs. surgical removal). [δ] Appropriately refurbished to extend life. [*] To be replaced by the NGB as appropriate. [#] U.S. nuclear umbrella argument. Future augmentation / inactive stockpile would include B83 until its life end. Total nuclear weapons on the order of 300-500; 2 deployed boats per ocean, 50-100 air-delivered (gravity and / or standoff).

Nothing is implicit with respect to the rate of ramp down between the current deployed stockpile and the suggested possible end state, but Figure 2 represents a notional representation of how the total stockpile might diminish in time. The rate should be determined, at least in part,

by the natural lifetime, reliability assessments, and existing test assets. The SLBM drawdown could be particularly slow, as there are no apparent strong drivers over the next couple of decades. A total stockpile on the order of 500 satisfies the principle objectives of strategic nuclear deterrence, in less asymmetric, more "rational" scenarios where strategic deterrence is a useful concept.[45] It poses the threat of certain destruction in the case of an escalating exchange.[46, 47] It provides flexible response at incremental use in case of extreme military or political necessity. It is credible, in both CONUS and forward-deployed scenarios. It minimizes risk, provides an enhanced surety deterrent, and can be sustained with a reduced complex.[48] With more "robust" warheads, the nondeployed stockpile can be reduced.[34] It distributes the deterrent across the two most useful delivery systems; at small numbers, the force structure is more important than the absolute number of warheads. The world is an uncertain place,[49] but some level of nuclear deterrence provides an "essential insurance against the uncertainties and risks of the future."[50]

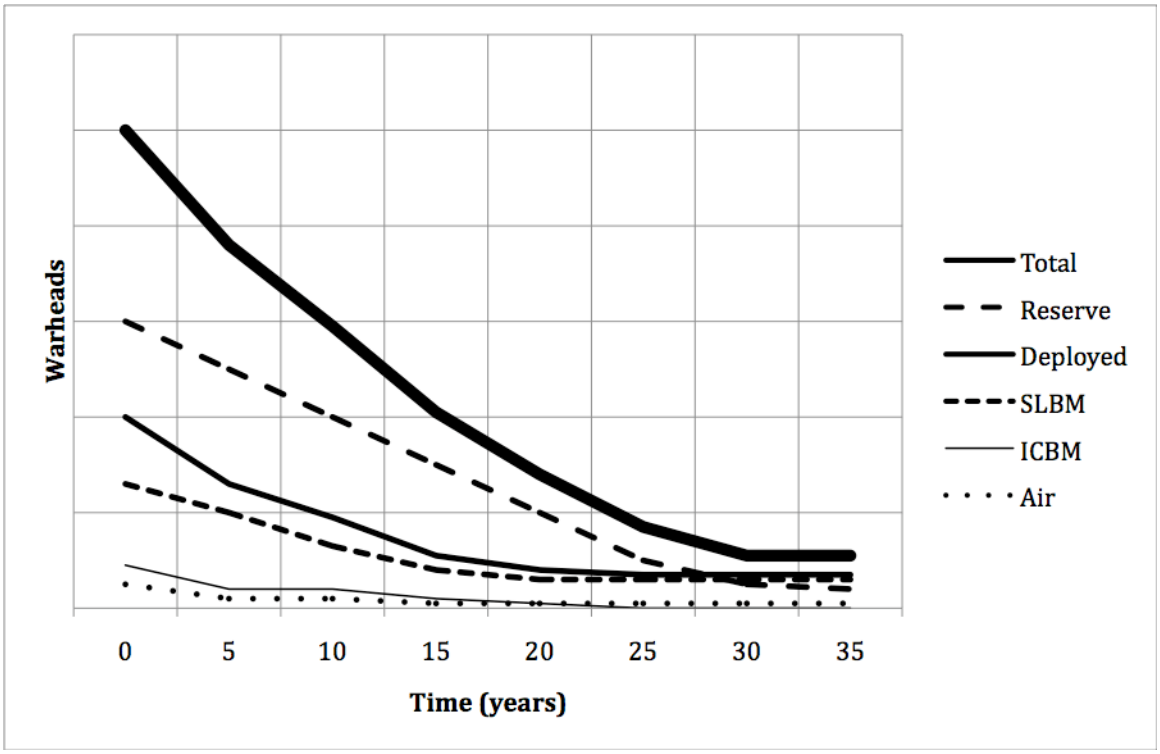

Figure 2. Notional rate of stockpile ramp-down. The expected lifetimes of existing warhead and delivery systems provides time to establish international framework through diplomacy and verification. Midway through the 21st century, the U.S. retains a substantial nuclear deterrent, but approximately an order of magnitude less than today.

The end state depicted in Table 4 will instantly provoke impassioned cries from certain niche camps (e.g., the pro-nuclear camp who strive for a risk-free and fiscal resource unconstrained world). Examples are as follows:

1) *Such a low level invites Russian superiority and Chinese parity.* First of all, the U.S. should re-engage Russia and China with respect to future arms control agreements (and subsequently or in tandem other Nuclear Weapon States).[51] Such a reduction provides the U.S. the opportunity to lead by example while not significantly sacrificing national security; in the final analysis both Russia and China will do what is best for them, and U.S. actions are only part of the equation. Secondly, so what? Russia and China have co-existed for decades over a contentious border with a large mismatch in conventional and nuclear forces. The point is not to have an equal deterrent, but to have a sufficient deterrent. China, France and the UK all have, from their viewpoint, sufficient nuclear deterrent. The force structure need not be determined by 100% coverage against a super-target set; the national strategy drives the numbers and the force structure, not vice versa. The potential bonus before the U.S. is to now have an opportunity to reduce the overall global nuclear weapons posture.
2) *Such reuse of existing stockpile components undermines the transformation of the complex and the infrastructure leg of the new Triad.* The U.S. has to make choices in a fiscally constrained future. In the absence of strong military or policy requirements, and

in a climate of stockpile reduction, it is hard to justify large future expenditures for a sunset industry. The time constant for reduction of the current stockpile is measured in decades. The leg of the old Triad most likely to be eliminated is the land-based ICBM force; the life-extended MMIII with the recently refurbished W87 has a projected lifetime on the order of 20 years, with severe doubts if it will ever be replaced. Now is not the time to issue a compelling call for new bricks and mortar.

3) *The U.S. has to guard against potential breakout and technological surprise*. True, but a newly configured weapons complex manufacturing weapons in the absence of requirements is not the most fiscally prudent insurance policy. The national laboratory system, if properly sustained, provides the first bulwark against technological surprise. The second is trickle production. To avoid manufacturing capability and responsibility is to invite disaster at both the national and organizational level. Understanding does not equal capability. And no non-academic U.S. organization has survived with only an R&D responsibility; Bell Labs, Sarnoff Research Center, and DuPont Central Research, have all withered as R&D became focused and customer-oriented. The very superiority of the quality of the U.S. nuclear weapon stockpile has endangered the survivability of the manufacturing base; Russia has a much more robust infrastructure. And trickle production, if sustained wisely, can ensure that manufacturing capability by diversifying the production base to include commercial enterprises for non-nuclear components. It is time for the nuclear enterprise to leverage the private sector.

And The Charm Is Firm and Good

The U.S. is at a decision point with respect to the future of the nuclear weapon enterprise. Numerous articles and books advocate one path or another; Congress is awaiting input prior to

their deliberations, and the new Administration will undoubtedly bring a fresh perspective.[52, 53] But it ultimately comes down to money, hundreds of B$ over the next 20 years. How much is nuclear deterrence worth? How much nuclear deterrence is enough? What is the best path to international security? What are the relative benefits of new diplomacy initiatives[54, 55] vs. a reconstructed nuclear deterrence? What is the balance between economic globalization and regional interests?[29]

There will always be nuclear weapons; the absence theorem can never be proven. But the multi-polar, asymmetric threat world of the future will require additional policy and military tools to adequately promote international security. So the U.S. has to decide on a fungible path forward, one that balances risk with Return-On-Investment, acceptable diversity (a debatable attribute when weighed against cost and strategic value) with commonality / interoperability, and a strategy that avoids premature capitalization. Evolution towards a nuclear weapons Dyad, with total stockpile (deployed plus reserve) well less than 1000, a sustainable military CONOPS, and trickle production centered at the National Laboratories but involving the private sector, will provide a sustainable strategy for the future.

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